Shipboard Crane Pendulation Control System

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Pendulation Control System (PCS

- PCS for T-ACS cranes compensates for:
  - Ship motions
  - Abrupt operator inputs
  - Residual cargo motions

- Participants include:
  - Sandia National Labs
  - MacGregor Cranes
  - BMT Designers & Planners
  - Craft Engineering
  - Michigan Technological University
  - Virginia Polytechnic Institute

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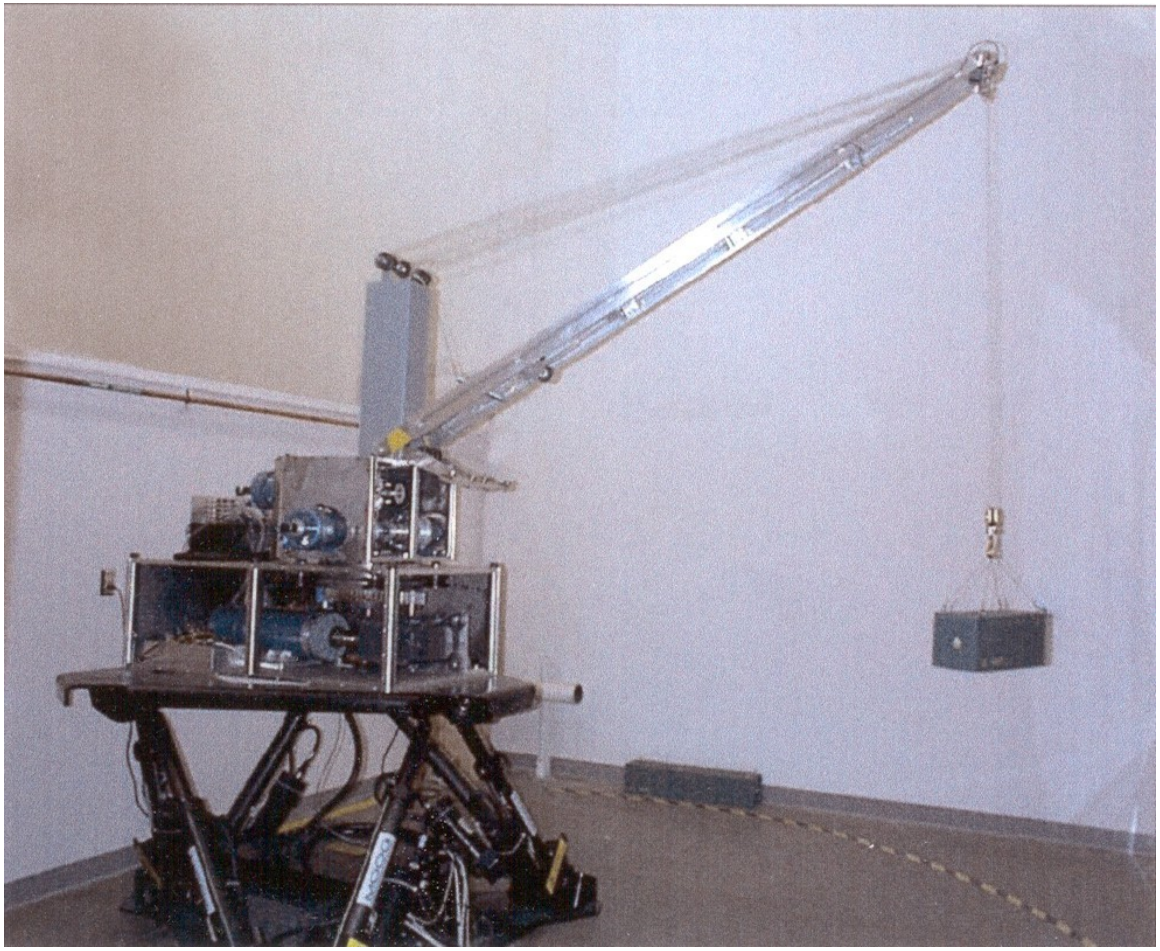
1/16th Scale Crane Model



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Crane Controls & PCS Computer

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Ship Motion Sensor

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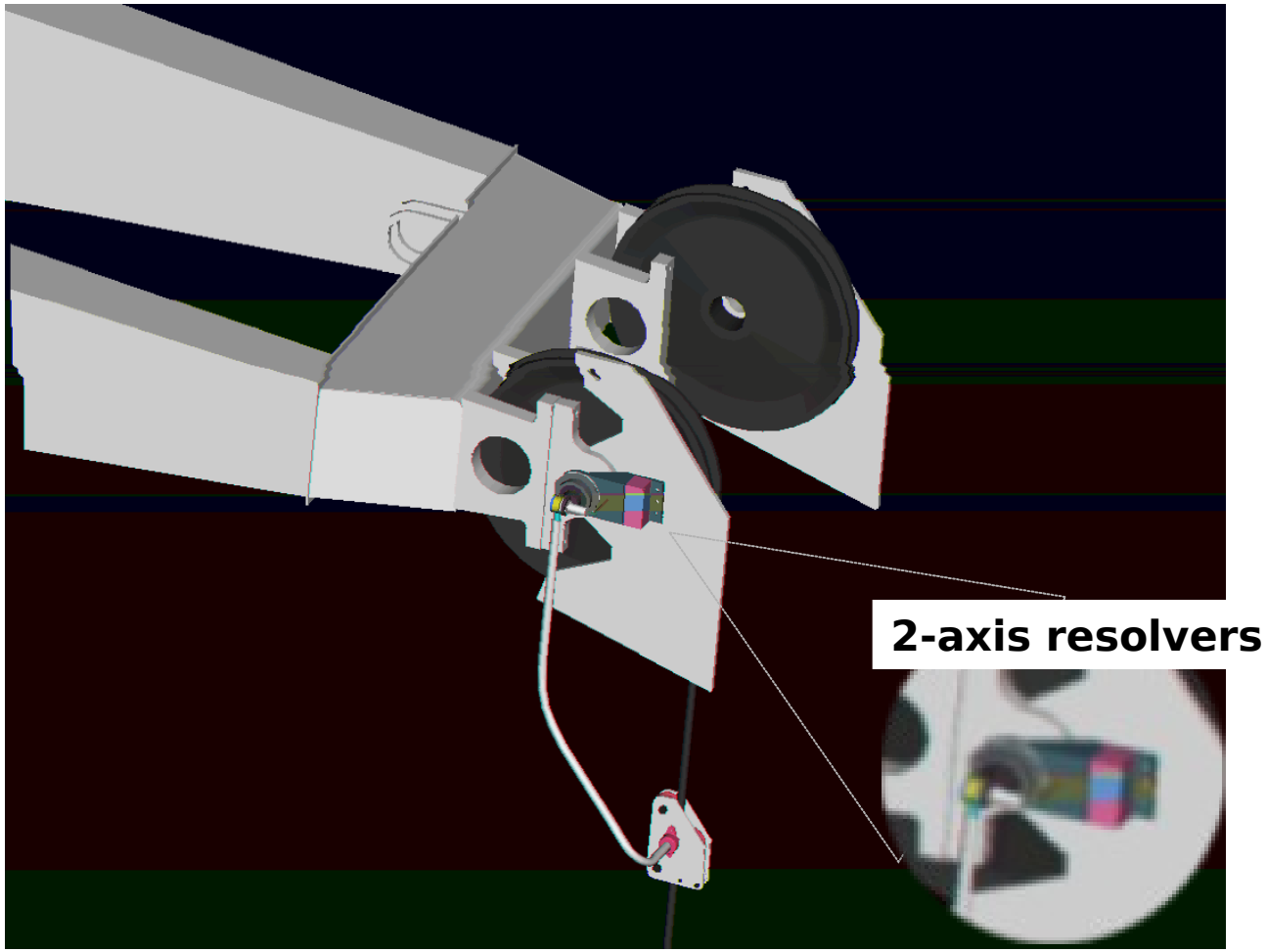
Payload Swing Sensor



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2002 ONR-Sponsored Pierside Demo

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Testing Results To Date

Fall ‘02 Demonstration

- Pierside testing on Flickertail State using Ship Roll Stimulator System
  - ➢ Established proof-of-concept of motion compensated crane
  - ➢ Collected motion and throughput data
  - ➢ Unable to exercise PCS to full capability alongside pier

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Testing Results To Date

October '03 Sealift R&D Demonstration

- At-sea "skin-to-skin" transfer [CONUS to Ship end of Seabasing]
- At-anchor offload demonstrations [LCU-2000, LCM-8]
  - Operated lee-side in SS2+ (SS3?) conditions
  - Operated from LCU via wireless remote
- At-anchor workspace "mapping"

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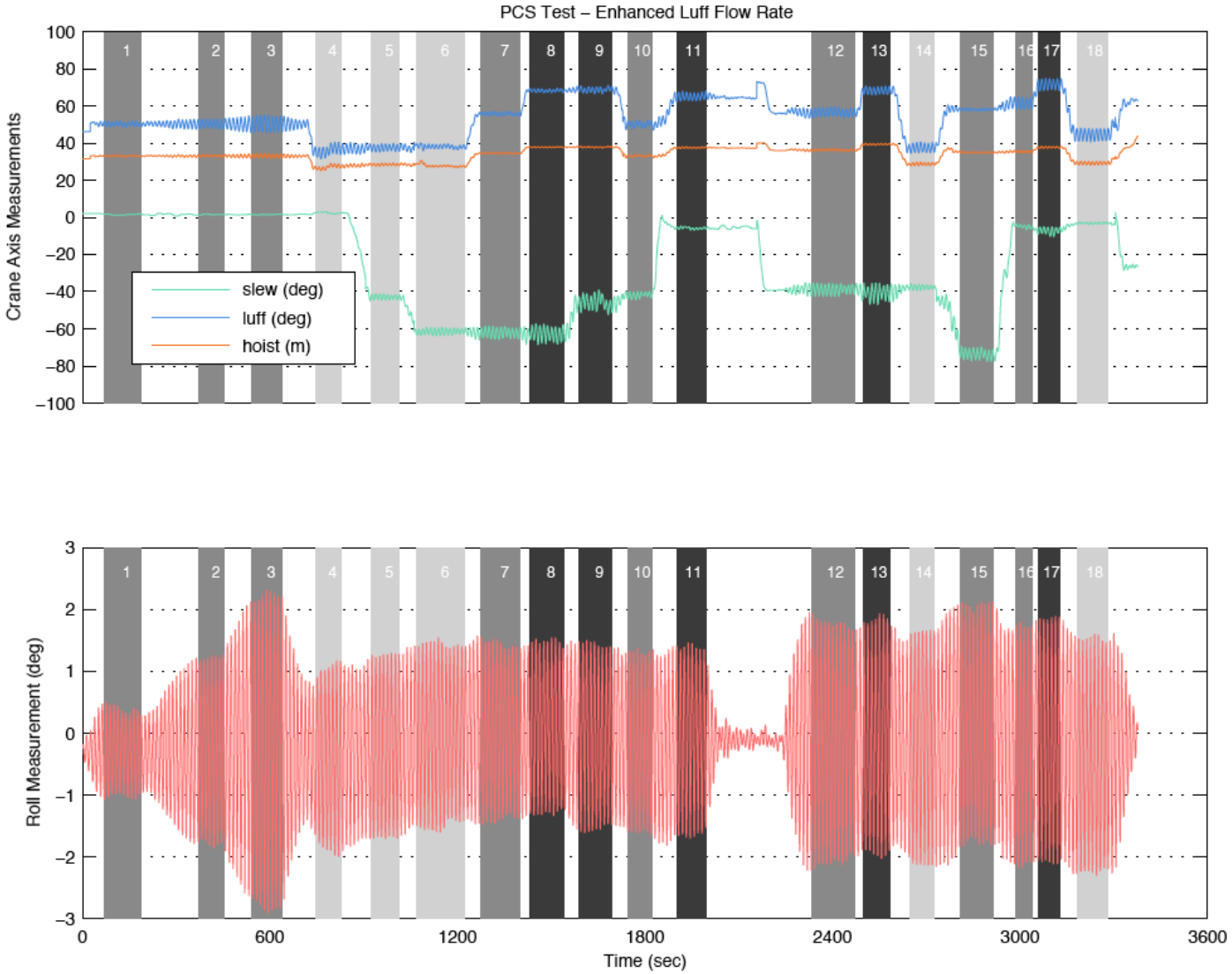
Workspace Analysis



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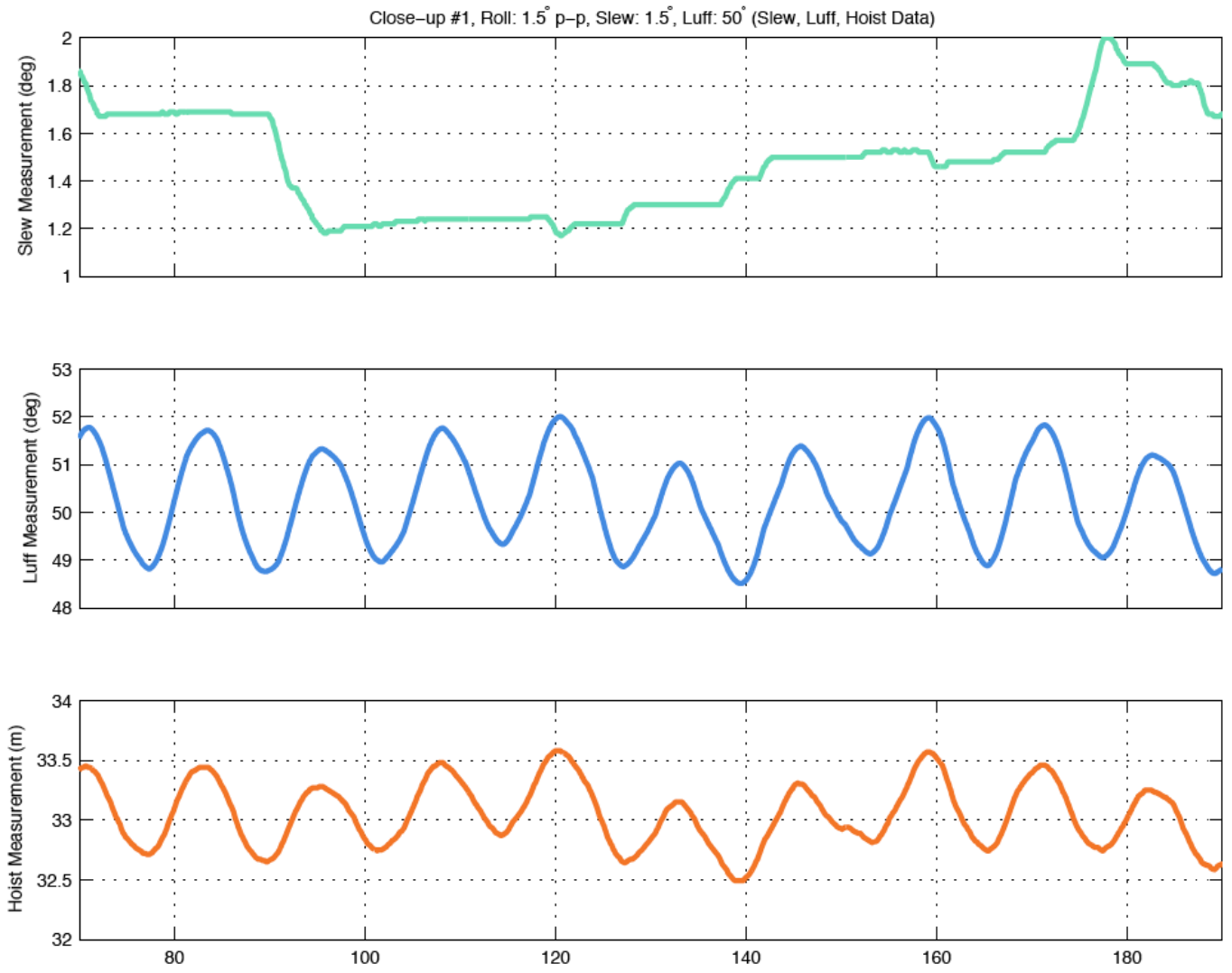
Event #1 Data – Magnified View



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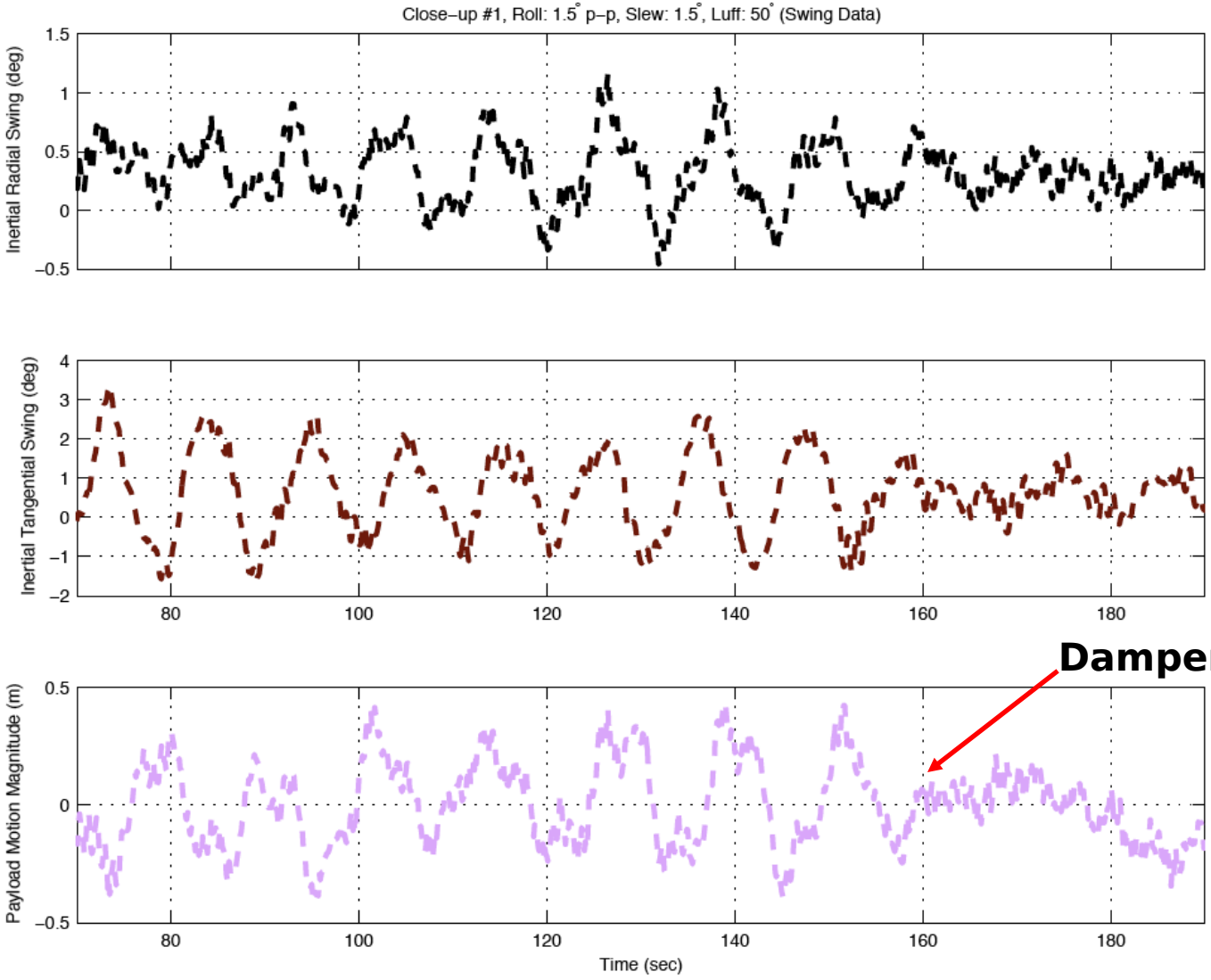
Event #1 Data – Payload Motion



Damper Engaged

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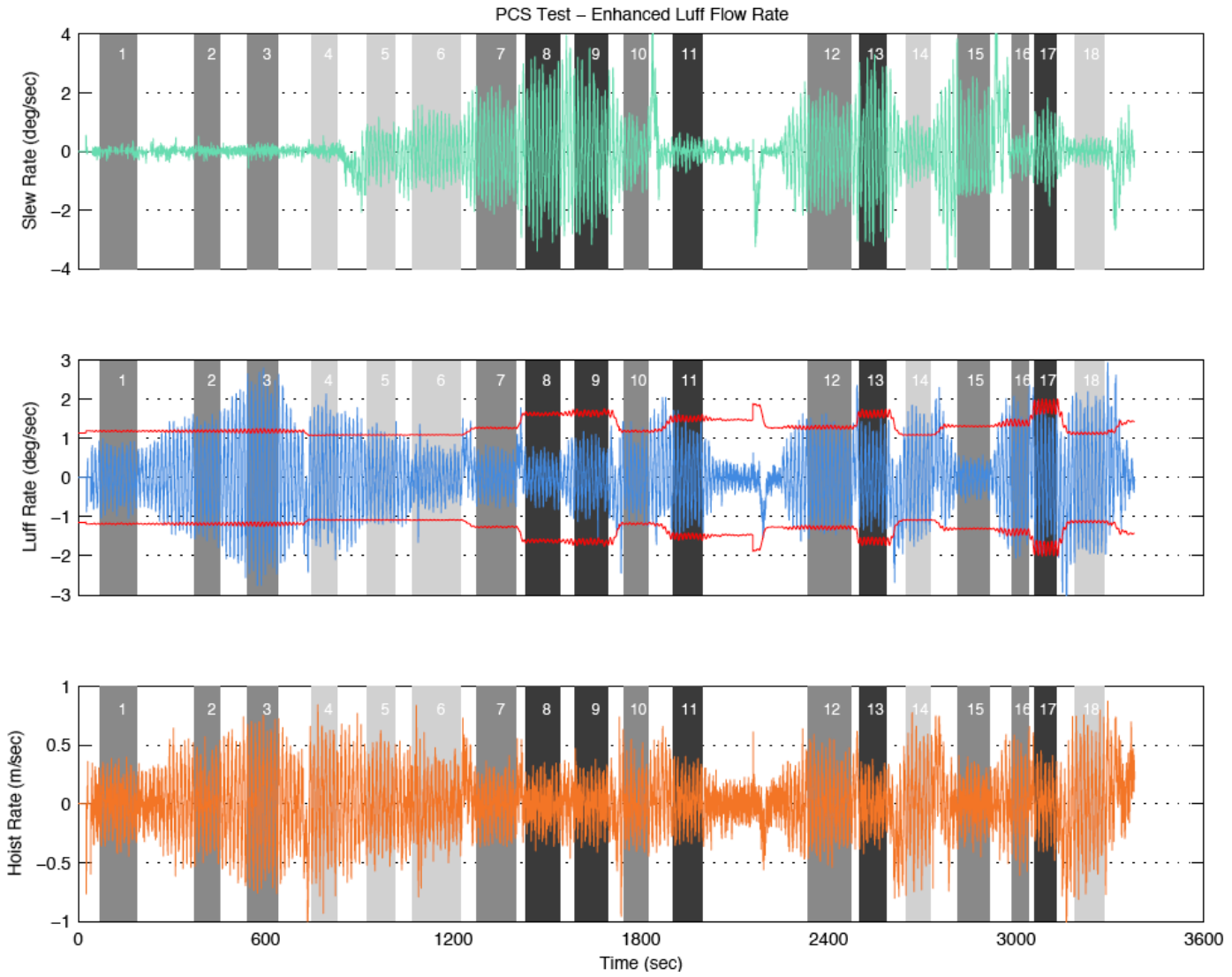
Rate Saturation Analysis



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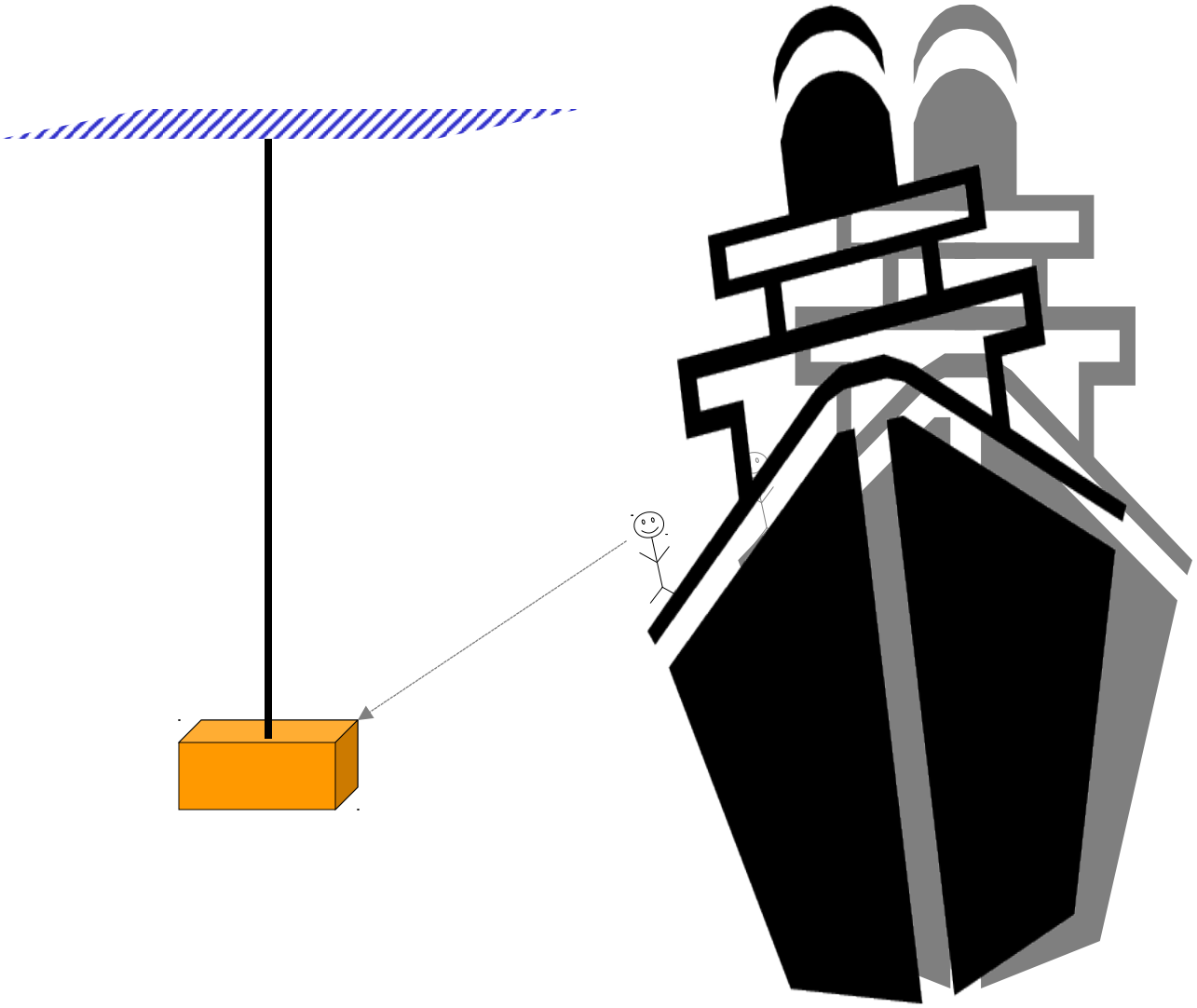
Inertial vs. Perceived Motion



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Directions for Future Development

- Payload motion sensor (laser beacon)
- Algorithm modifications
  - Transition from inertial to ship-fixed frame of reference
  - Allow tracking of vessel alongside
  - Accommodate ship forward motion
- Ship motion sensor
- Throughput enhancements
  - Spreader-bar messenger frame
  - Deck placement guides
  - Add'l improvements to wireless remote
  - Operator interface / position indexing

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2003 At-Sea Demo

Skin-to-Skin Transfer

Questions?